

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC REALITY OF THE MARTIAN CANALS.—No. 4021 of the *Astronomische Nachrichten* contains a telegram dated May 28 from Mr. Lowell to Prof. Pickering in which the former states that several of the canals on Mars have been photographed by Mr. Lampland. Amongst others, Nilo Syrtis, Casius, Vexillum, Thoth, Cerberus, Helicon, Styx, Chaos, and Lieheus (? Libneus) are shown on the negatives, some appearing on more than twenty plates.

DISCOVERY OF SATURN'S TENTH SATELLITE.—A brief note in No. 4015 of the *Astronomische Nachrichten* states that Saturn's tenth satellite was discovered from an examination of several plates taken with the 24-inch Bruce telescope which were selected from those used in the determination of the orbit of Phoebe.

The new satellite appears on thirteen plates. The orbital motion is direct and the period is twenty-one days, therefore the satellite is apparently a little nearer to Saturn than is Hyperion.

JUPITER'S SIXTH AND SEVENTH SATELLITES.—An abstract from vol. xvii. of the *Publications of the Astronomical Society of the Pacific*, appearing in No. 4015 of the *Astronomische Nachrichten*, contains an account by Prof. Perrine of the observations so far made of Jupiter's sixth and seventh satellites.

The former can be photographed in ten minutes with the Crossley reflector, and thirty-six plates have been obtained. A preliminary investigation of the orbit shows that the inclination to the ecliptic and the planet's equator is about 30° , and that the satellite has a period of about 250 days, with a mean distance from the planet of 7,000,000 miles. The direction of the orbital motion still remains uncertain. The brightness of the satellite indicates a diameter of about 100 miles, or less.

On examining the plates taken for the sixth satellite on January 2, 3, and 4, a much fainter object, also apparently belonging to Jupiter, was discovered, which was then situated N. and W. of, and was moving towards, the planet. Subsequent observations, which, owing to the satellite's faintness, were much more difficult to make than in the case of the sixth satellite, confirmed its dependence upon Jupiter. This object was not shown on the negatives taken for the sixth satellite during December, being just outside their field, but altogether twenty observations have been made, the last on March 9.

Apparently the orbit of the seventh satellite is quite eccentric, with a mean distance from the planet of about 6,000,000 miles and a period of about 200 days. The inclination of the orbit to the plane of Jupiter's equator is about 30° , but the direction of the orbital motion is as yet undetermined. The photographic magnitude of the seventh satellite is not brighter than the sixteenth, and on comparing this with the magnitudes of other satellites and of asteroids a diameter of about 35 miles is deduced.

Prof. Perrine suggests that the large inclination of their orbits indicates that neither of these bodies were originally members of Jupiter's family, but have been "captured" by the planet.

STARS WITH SPECTRA OF THE ORION TYPE.—In No. 2, vol. lvi., of the *Annals of the Harvard College Observatory*, the distribution of stars having class B or Orion-type spectra is discussed, and all known stars of this type placed in a catalogue, in order of R.A., the position (1900-0), magnitude, exact type of spectrum, and the galactic longitude and latitude being given for each star. Considerably more than 30,000 spectra have been examined by Mrs. Fleming in connection with the Henry Draper memorial work, and of these 803 are included in the present catalogue.

As a distinctive feature of these stars is the helium indicated in their spectra, the allocation of them with regard to galactic longitude and latitude really indicates the distribution of helium in the universe. On thus classifying them, it is found that on dividing the sky into equal areas the galactic latitudes of which are included between $+90^\circ$ and $+30^\circ$, $+30^\circ$ and 0° , 0° and -30° , and -30° and -90° , the numbers of well marked helium stars in these divisions are 22, 219, 509, and 53, or 3, 27, 63,

and 7 per cent. of the total respectively, nine-tenths of them being within 30° of the galactic equator. A congregation in certain galactic longitudes is also indicated. Thus between 160° and 340° there are 613, or 78 per cent. of the total, of these stars. About one-quarter of the whole number are contained in four regions having a total area of 790 square degrees, or less than one-fiftieth of the sky. One of these four regions is near to the variable star I Carinae, and lies almost wholly within the constellation Argus. As this Argus region contains nearly three times as many "Orion" stars as does the Orion region, Prof. Pickering suggests that "Argus" stars would have been a more suitable generic name for the class of stars having spectra of this (B) type. He states, however, that the nebula of Orion appears to be the starting point, or origin, of class B stars, twenty of which are situated within 1° of θ Orionis, that is to say, nearly as many as are contained in the region between galactic latitudes $+30^\circ$ and $+90^\circ$, although the area of the latter region is three thousand times as great.

Arranging them according to magnitude, it is found that most of this class are bright stars, only 1 in 20 being of the sixth or fainter magnitudes.

THE MOTION OF THE TAIL OF BORRELLY'S COMET (1903 iv).—From the examination of a number of photographs obtained by different observers during July, 1903, Prof. Jaegermann, Moscow, has compared the relative motions of the different sections of the tail of comet 1903 iv in regard to the movements of the comet's nucleus and to the sun. After analysing the velocities and movements determined, he has arrived at the conclusion that in this case light-pressure, acting in the sense of Arrhenius's hypothesis, was not the determining factor in the formation of the several tails, for a pressure sixty times greater than gravity would have to be assumed. If the light-pressure hypothesis be retained, the assumption must be made, according to Bredichin's idea, that the tail-matter consisted of gaseous molecules, and that its illumination was due to the fluorescence of highly illuminated gases, such as has been experimentally demonstrated by Lommel, Wiedemann, and Schmidt.

The existence of a repulsive force, other than light-pressure, was demonstrated by Bredichin in comet Rordame (1893 ii), by Prof. W. H. Pickering in comet Swift, and was confirmed by Prof. Jaegermann in a preliminary investigation concerning the denser parts of the tail of comet Swift, 1892 i.

DOUBLE STAR OBSERVATIONS.—The results of a series of observations of double stars made at Kirkwood (Indiana) Observatory are given in No. 4022 of the *Astronomische Nachrichten*. The observations were made by Mr. J. A. Miller and Prof. W. A. Cogshall with a 12-inch refractor, and the B.D. and A.G. numbers, the 1875 position, the magnitudes, and the measured position-angle and distance are given for each of 114 double stars.

The objects observed were selected from those noted as double by the Leipzig observers when preparing the A.G. catalogue for the zone $+10^\circ$ to $+15^\circ$, and, with few exceptions, they have not been measured elsewhere. Some few stars suspected by the Leipzig observers as duplicate could not be seen as such by the Kirkwood observers, and one or two of the sets of measures refer to newly discovered double stars.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last, June 3, the Board of Visitors made their annual inspection of the Royal Observatory, Greenwich, but unfortunately, through ill-health, the Astronomer Royal was not able to be present. The following is a brief abstract of the report which was submitted to the visitors.

Very great progress has been made in the observation of the reference stars for the Greenwich section of the Astrogaphic Catalogue, about 9500 observations of R.A. and N.P.D. having been added during the year. The comparatively few observations required to secure five observations of each of the reference stars (more than 10,000 in number) will easily be obtained by the end of the year, as there are only 5 stars requiring three observ-

ations, 100 requiring two, and 1500 requiring one observation only in order to carry out the programme. In fact, it may be taken that the observations for this catalogue are practically completed. The catalogue, which will be terminated this year, will contain, besides the reference stars for the Astrographic Catalogue, the 834 zodiacal stars given in the Nautical Almanac for 1897.

It is proposed to begin next year a new nine-year catalogue of the stars of magnitude 9.0 and brighter between the limits $+24^\circ$ to $+32^\circ$ of N. declination, this being the Oxford astrographic zone, for which they serve as reference stars. The re-observation of these stars, which for the most part fall within the Cambridge zone of the *Astronomische Gesellschaft* Catalogue, will afford valuable data for their proper motions, besides giving fundamental positions for the Oxford astrographic plates.

The comparison between theory and the Greenwich meridian observations of the moon from 1750 to the present time, undertaken by Mr. Cowell, has been completed for the longitudes, and the discussion from 1847 to 1901 is completed for the latitudes. The only point left outstanding is the motion of the node, for which it is necessary to discuss as long a series of observations as possible. The results obtained for the longitudes are summarised in a series of papers in the *Monthly Notices of the Royal Astronomical Society*. In particular, the paper in vol. lxx., No. 2 (1904 December), gives the coefficients of 145 terms as obtained directly from observation, with a comparison with the theoretical coefficients given by Hansen, Delaunay, M. Radau, and Dr. Hill. The publication of the details of the whole investigation will be shortly proceeded with.

The re-reduction of Groombridge's observations was completed at the date of the last report, and during this year the printing of the results has been pushed on. The introduction has also been prepared for press. A discussion of the proper motions determined by comparison with modern Greenwich observations, and a determination of the constant of precession and of the direction of the solar motion by Mr. Dyson and Mr. Thackeray, are given in the *Monthly Notices of the Royal Astronomical Society*, March.

The altazimuth has been in regular use throughout the year, and a second determination of the pivot errors has been made, and also observations for obtaining the value of one revolution and errors of the screw of the telescope-micrometer have been completed.

The observations of the moon, both in and out of the meridian, seem very satisfactory as shown by the agreement between the two instruments, the transit circle and the altazimuth.

The 28-inch refractor has been employed, as was the case last year, for micrometric measurements of double stars, the total number measured being 603. Of these, 143 have their components less than $1''.0$ apart, and 60 less than $0''.5$. A marked deterioration of the images of the stars led to an examination of the lenses, and the suspected tilt between the components was corroborated and remedied.

Sixty-five photographs of Neptune and its satellite have been secured with the 26-inch refractor, while, with the 30-inch reflector, numerous photographs of minor planets and comets *a*, *b*, *c* 1904, and *a* 1905, have been obtained.

At the date of the last report, 119 plates taken of Eros with the astrographic equatorial, and 55 taken with the Thompson equatorial, had been measured. During this year the remainder of the photographs have been measured, making in all 198 with the astrographic equatorial and 152 with the Thompson instrument. The reduction of the measures is in a satisfactory state, and it is expected that it will be completed in two months for both sets of photographs.

The astrographic equatorial has been employed mainly to obtain photographs to replace chart plates which show slight photographic defects unsuitable for production of enlarged prints.

The measurement of the catalogue plates for the Greenwich section is now completed. Since the last report 47,200 measures of pairs of images (6m. and 3m.) have been made. The number of plates measured in the year is 102, covering 128 square degrees between declination

83° and the pole. The number of plates measured up to the date of last year's report was 1051. Adding the 102 plates measured this year, the total number of plates measured is 1153, being the 1149 of the Greenwich section + 4 additional photographs of the polar field.

For the year ending 1904 December 31, Greenwich photographs of the sun have been selected for measurement on 209 days, and photographs from India and Mauritius (to fill up the gaps in the series) on 151 days, making a total of 360 days out of 366 on which photographs are at present available. Photographs were taken in Mauritius for three of the six days yet unrepresented, and may be received in due course.

The solar activity has shown a great increase during the year ending 1905 May 10, and the sun has not been free from spots on a single day during that period. The mean daily spotted area for 1904 was more than half as great again as that for 1903, and early in the present year a number of exceptionally large groups was observed. The group which was seen first on the east limb on 1905 January 28 had a greater total area than any other group which has been photographed at the Royal Observatory.

The principal results of the magnetic elements for 1904 are as follows:—

Mean declination		$16^\circ 15' 0''$ West.
Mean horizontal force		$\left\{ \begin{array}{l} 4.0166 \text{ (in British Units).} \\ 1.8520 \text{ (in Metric Units).} \end{array} \right.$
Mean dip (with 3 needles)		$66^\circ 57' 11''$.

In 1904 there were no days of great magnetic disturbance and eight of lesser disturbance.

The mean temperature for the year 1904 was $49^\circ.8$, or 0.3 above the average for the fifty years 1841–90. During the twelve months ending 1905 April 30 the highest temperature in the shade (recorded on the open stand in the magnetic pavilion enclosure) was $91^\circ.0$, on August 4. On the same day the highest temperature in the Stevenson screen in the magnetic pavilion enclosure was $89^\circ.5$, and in the observatory grounds $89^\circ.7$. The lowest temperature of the air recorded in the year was $19^\circ.5$, on January 1. During the winter there were thirty-nine days on which the temperature fell below $32^\circ.0$, being seventeen less than the average number.

The mean daily horizontal movement of the air in the year ending 1905 April 30 was 280 miles, which is 2 miles below the average of the preceding thirty-seven years. The greatest recorded daily movement was 867 miles, on November 9, and the least 49 miles, on December 22. The greatest recorded pressure of the wind was 23.5 lb. on the square foot, on March 12, and the greatest hourly velocity 45 miles, on December 30.

The number of hours of bright sunshine recorded during the twelve months ending 1905 April 30, by the Campbell-Stokes instrument, was 1486 out of 4457 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0.333, constant sunshine being represented by 1.

The rainfall for the year ending 1905 April 30 was 20.21 inches, being 4.33 inches less than the average of the fifty years 1841–90. The number of rainy days was 153. This small rainfall may be contrasted with the heavy rainfall of 35.42 inches in the corresponding period last year. The most striking contrast is obtained by comparing the rainfall for the year commencing 1903 March 1, which was more than 37 inches, with that for the year commencing 1904 March 1, which was less than $17\frac{1}{2}$ inches. This dry period of twelve months was followed by a heavy rainfall in 1905 March, which exceeded $3\frac{1}{2}$ inches, and is the greatest amount recorded in March since 1851.

The printing of the Paris-Greenwich longitude determination, 1902, is practically complete. The Killorglin longitude is the only determination which still requires to be printed to complete the volume of longitude determinations, which will contain the determinations Paris-Greenwich made in 1888, 1892, and 1902, of Greenwich-Waterville-Canso-Montreal made in 1892, and of Greenwich-Killorglin made in 1898.

The re-reduced Groombridge Catalogue is nearly completely printed, with the exception of the introduction, which is ready for the press.

Provision has been made in the Navy Estimates for the observation of the total solar eclipse of 1905 August 30 by a party of three observers on the coast of Tunis, where the weather conditions are promising. It is proposed to take photographs of the corona for detail and extension with the Thompson 9-inch coronagraph, the 13-inch astrographic refractor, and the 4-inch Dallmeyer rapid rectilinear lens, and also photographs of the spectrum with the two spectroscopes lent by Major Hills, R.E., as in 1900 and 1901.

THE OPTICAL CONVENTION.

THE optical convention has just concluded a very successful meeting extending over four days; the exhibition and the papers attracted numerous visitors from all parts of the country. The papers led to much valuable discussion. An account of the exhibition and the president's address appeared in last week's NATURE.

The first group of papers dealt with the design of optical and scientific instruments. The Gauss theory was entrusted to Mr. Conrad Beck, who considered the theory of the equivalent planes of complete optical instruments; he dealt more particularly with the complete microscope in relation to its "working distance."

Dr. Drysdale gave a general account of the aberrations of lens systems, submitting a classification and specification of the various aberrations to obtain an expression of opinion from those working at the subject. Mr. Chalmers gave a graphical method of representing the results of calculations of lens systems, and a modification of the Hartmann system of testing to permit of measuring and expressing aberrations in exactly the same form. This should make it possible to obtain the relation between the definition and the measured or calculated aberrations. In the discussion Mr. Carson pointed out the importance of the relative intensity of the image disc and the aberration patch in estimating the performance of lenses.

Mr. Walter Rosenhain criticised the mechanical design of certain types of instruments; he showed that, in many cases, the ideals of the instrument maker were in conflict with sound engineering principles, and suggested directions in which improvements might be looked for.

Diffraction in optical instruments was discussed by Mr. J. W. Gordon in an important theoretical paper; his conclusions, which would modify many of our ideas on optical systems, are now being submitted to a definite experimental test.

A group of papers related to interference phenomena. Mr. J. Rheinberg exhibited a method of producing achromatic interference bands which is likely to have numerous applications. Mr. Stansfield described a simple form of Michelson interferometer specially suitable for demonstration. Prof. Watkin and Mr. Morrow exhibited their apparatus for calibrating extensometers by observing the displacement of interference bands.

Mr. Twyman described the manufacture of the Echelon spectroscope, stating the accuracy required in the plates and the precautions used to obtain it. This apparatus was exhibited and compared with the Lummer "parallel plate" arrangement for obtaining resolution of spectrum lines. Mr. Blakesley discussed the various forms of prism which could be used in constant deviation spectroscopes and some of their applications. Mr. Newall dealt with astronomical spectroscopes, demonstrating that the limits of usefulness of the present type of spectroscope were almost reached in the case of faint stars, as the intensity of light necessary for photographing their spectra can only be obtained at the sacrifice of the purity of the spectrum or the certainty of identification of the lines, and that no very marked improvement is likely to be obtained from the use of larger objectives, on account of the increased absorption in the prisms required. He suggested the use of gratings.

Lord Rayleigh dealt with the subject of polish, pointing out the distinction between the process of grinding, which consists of the removal of comparatively large flakes, and that of polishing, which he regards as molecular, the roughnesses of the surface being reduced to dimensions smaller than the wave-length of light. Experiments on the thick-

ness of glass removed by polishing and by etching with hydrofluoric acid under various conditions were illustrated. In the discussion Mr. Walter Rosenhain cited evidence to show that the surface flow which has been recognised in the polishing of metals also occurs in glass.

Mr. Walter Rosenhain dealt with the possibilities of progress in optical glass; he described the limitations to the production of vitreous fluxes of extreme properties, and advanced the view that media of widely different optical properties could only be obtained by the production of large homogeneous crystals. Physicochemical considerations were cited to indicate lines upon which this difficult problem might be solved.

A number of instruments for optical measurements were described, Prof. Poynting exhibiting his form of parallel plate micrometer. Mr. Blakesley described his apparatus for the measurement of focal length of lenses, with applications to other optical measurements. Mr. Chalmers described a new form of refractometer for obtaining the refractive index of glass in lens form. The lens is inserted in a trough containing a suitable transparent liquid, and the difference of the refractive indices is deduced from the approximate curvatures of the lens and its power in the liquid, with an accuracy comparable with that of the best refractometers.

Mr. Baugh described the use of invar tapes for baseline measurements.

Dr. Drysdale discussed the requirements of small telescopes and binoculars, with special reference to the field of view and illumination of the image. He indicated the method he had employed in calculations for prism binoculars, showing how he had been led to use glass of high refractive index for the prisms. He described a special form of photometer for determining the absorption in binoculars.

Mr. A. C. Jolley gave a critical review of photometric standards and apparatus; he described a modification of the Violle platinum standard, and discussed the difficult problems connected with heterochromatic photometry; his results indicate that the accuracy claimed by Sir W. Abney is far too high, especially when readings by different observers are compared. He concludes that a discrimination photometer is the most trustworthy instrument for comparing different colours.

Mr. Milne exhibited his new form of spectrophotometer. The apparatus is especially suitable for determinations of the absorption of light of specified wave-length by liquids.

Mr. Bull discussed the theory of tricolour filters, plates, and inks. He concluded that it was most satisfactory to adjust each independently of errors in the adjustment of the others. The filters should have a certain amount of overlap, the colour of the overlap of two filters being the colour of the printing ink corresponding to the other filter.

Mr. Crawley discussed the limits of stereoscopic vision; the results of his measurements point to a much greater accuracy in judging distances by stereoscopic effect than is generally admitted.

Mr. H. L. Taylor discussed the effects of astigmatism on the accommodation of the eye. Two new forms of ophthalmometer were demonstrated, one being the Ettles-Curties, which is valuable for the perfection of its mechanical adjustments, and the use of complementary colours for the mires; it is so arranged that the corneal microscope can be readily attached. The ophthalmometer shown by Mr. Sutcliffe contains a number of variations from ordinary forms; the mire is an almost complete ring illuminated by a special lamp, and the method of doubling the image is novel.

Dr. Walmsley gave an account of the attempts which have been made to provide technical education for those engaged in the optical industry, and the existing facilities; he outlined the scheme for the establishment of a British Institute of Technical Optics. The convention decided to memorialise the London County Council to support the scheme.

Major-General Waterhouse gave an account of the history of telephotography.

In the evening lecture, Prof. Silvanus P. Thompson gave a most interesting account of the various forms of Nicol's prism and its modern equivalents.